RESEARCH DEPARTMENT

ACOUSTIC TESTS ON THE WALKER MEMORIAL HALL, BIRMINGHAM

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SUMMARY

Acoustic tests carried out before and after modifications to the Walker Memorial Hall, Birmingham are described. Floor resonances which caused unacceptable musical quality were satisfactorily removed.

1. INTRODUCTION

The Walker Memorial Hall is situated near to Broadcasting House, Birmingham, and has been used for occasional light music broadcasts. A part-time lease has now been arranged with the owners and it will be used for sound programmes in place of Studio 4, Broad Street, which has been acquired by Television Service.

The building is of 9-inch (230 mm) brickwork with a slated outer pitched roof. There is a false ceiling of wood lath and plaster attached to joists which extend almost to the eaves at both sides. The internal dimensions are 42 ft (12·7 m) × 21 ft (6·3 m) × 14 ft 7 in. (4·5 m) high. A dado of tongue-and-grooved boarding extends 4 ft (1·23 m) up the walls.

The floor consists of secret-nailed tongue-and-grooved oak strip on joists supported by two sleeper walls 18 in. (0·5 m) high running the length of the hall at equal spacings between the sides. It was noticeably compliant between the lines of the sleeper walls.

2. FIRST MEASUREMENTS, DECEMBER 17th 1963

2.1. General

A preliminary visit was made in 1963 to assess the suitability of the hall as a music studio. On this occasion, the last 10 ft (3·1 m) of the hall was occupied by rostra 2 ft (600 mm) high, forming a stage which was provided with curtains and back-drapes. There were also curtains over the windows along one long side of the hall. It was reported that music was unacceptable in the studio on account of excessive bass reverberation, suspected to be associated in some way with the springy floor.

2.2. Noise and Sound Insulation

The noise background was typical of a quiet suburban district, the only observed noises being from traffic on the road, vehicles entering and leaving the car park at the rear of the hall, and a nearby motor mower.

The brickwork of the hall would be expected to give reasonable protection from these sounds but they were transmitted freely through open fanlights, the light unsealed wooden doors and the large areas of ordinary window glass.

In these circumstances measurements of the existing sound insulation would have given no information, and it was therefore decided to recommend treatment of the weak points only by the fitting of studio type doors and heavy wooden window shutters. It would not be practicable to give protection against the noise of low-flying aircraft.

2.3. Acoustics

Fig. 1 shows the reverberation curve of the hall before alteration. There was a steep rise at low frequencies, reaching 1·3 sec at 90 c/s. There was also a general maximum centred on 1400 c/s. The high reverberation times at low frequencies were associated in many cases with marked double decays. There were long rings heard when pulsing the studio with tone of frequencies up to 1 kc/s or more, apparently associated with the maximum of the curve in this region. These rings were found to be connected with standing-wave systems between the floor and ceiling. They could be treated by absorbers mounted on the ceiling.

2.4. Accelerometer Measurements

As the long double-decays at low frequencies could be due to floor resonances an accelerometer

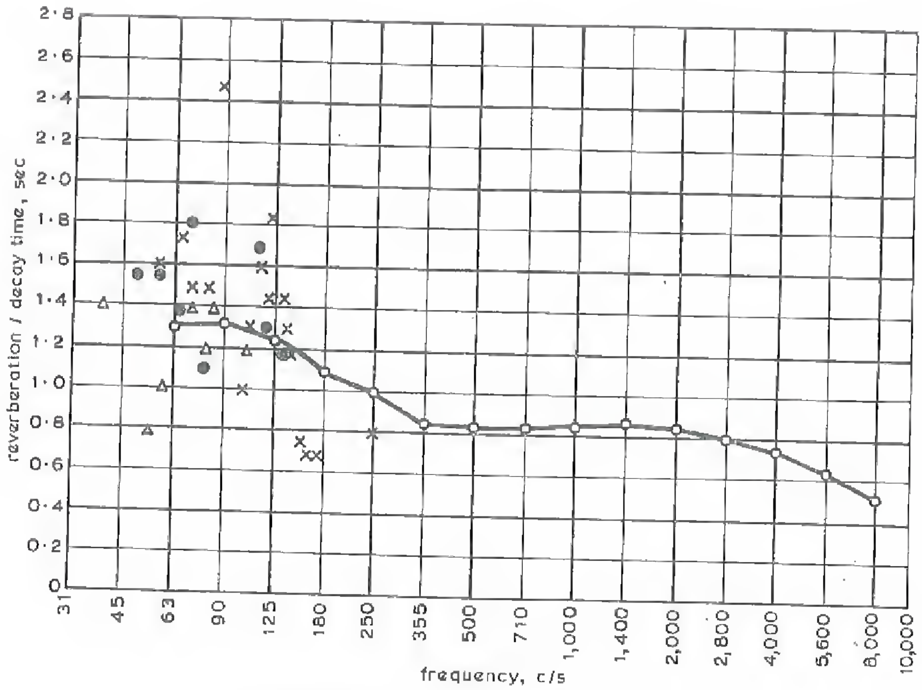

Fig. 1 - Measurements before modification

—o— Reverberation time
× Floor decay times at resonance, central area
● Floor decay times at resonance, towards one end
Δ Floor decay times at resonance, over sleeper walls

was attached to various points on the floor and the hall again excited by tone from the loudspeaker. The decay times were measured at every frequency at which there was a maximum of floor vibration. Two groups of accelerometer positions were chosen, one group on the centre line between two sleeper walls and the other over the sleeper walls. The decay times are plotted in Fig. 1 against the frequencies of maximum resonance. It will be seen that the points are all in the region of maximum room reverberation time and that many are well above the reverberation curve.

2.5. Recommendations

The relationship between the floor measurements and the reverberation curve was taken as a strong indication that floor resonances accounted for the double-slope decays observed in the reverberation measurements, and therefore for the subjective "boominess" of the studio when used for music. The most important recommendation was therefore that the floor should be stiffened and effectively damped.

The optimum reverberation time for the volume of 12,200 ft^3 (346 m^3) is approximately 0·75 sec. About 350 ft^2 (32·5 m^2) of bonded bass or equivalent absorbers would be required to reduce the low-frequency reverberation to this time and the high frequency reverberation should be increased by the removal of the curtains.

3. MODIFICATIONS CARRIED OUT

3.1. Changes to the Structure

The floor was stiffened by a method devised by Building Department. Angle-iron stakes were screwed at their upper ends to the floor joists and the lower ends were anchored to the ground by pouring concrete six inches deep over the feet. Though the nature of the ground precluded any positive adhesion the footing thus formed at each point prevented downward deflection of any part of the floor. Enough concrete was used to provide bridges between adjacent footings so that they were substantially joined together in continuous rows.

The fanlights were closed and the windows provided with heavy timber hinged shutters. New doors of the self-closing studio type were fitted.

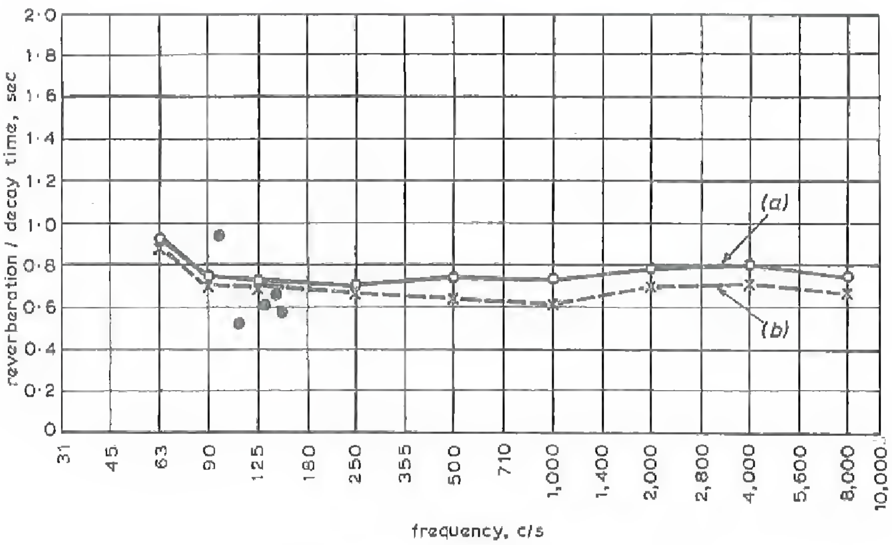

Fig. 2 - Measurements after modification

(*a*) Measured reverberation time
(*b*) Estimated reverberation time with curtains (run-back)
● Measurements of floor decay times at resonance frequencies

An observation window was formed in one long wall, communicating with a control cubicle measuring 10 ft 4 in. (3·15 m) × 9 ft 2 in. (2·8 m). The control cubicle is a brick construction with a wood-wool inner ceiling.

3.2. Acoustic Treatment

The acoustic design was also carried out by Building Department. 300 ft^2 (28 m^2) of single roofing-felt membrane absorbers, 6 in. (150 mm) deep, were added, together with a smaller area of 1 in. (25 mm) Stillite SR.10A behind 25% perforated hardboard covers. The curtains were removed except for the lined velour stage curtains.

4. ACOUSTIC MEASUREMENTS AFTER MODIFICATION

4.1. Acoustics

Subsequent tests were conducted on October 14th 1965, the studio being in the condition described above, except that the stage and curtains were absent. The measured reverberation-time curve is displayed in Fig. 2(*a*) and shows a close correspondence with the design value of 0·75 secs. Curve 2(*b*) is included in the figure to show the expected changes caused by the addition of the stage curtains in a "run-back" position. The slight increase in reverberation times at frequencies above 1 kc/s was noticeable subjectively, the studio having a rather "bright" sound.

4.2. Accelerometer Measurements

Accelerometer measurements of the vibration of the floor are included in Fig. 2 and show that the modifications to its structure have been successful in eliminating the high Q of the resonances. All floor vibration decay times are now shorter than, or comparable with, the room reverberation time, and the previously observed colourations due to the floor cannot be heard.

4.3. The Cubicle

Since building operations were still in progress it was not possible to conduct measurements of the transmission losses through the observation window because of the presence of many flanking paths through un-plugged cable ducts, etc. The reverberation time curve for the cubicle is plotted in Fig. 3(*a*) which, due to the absence of the carpet and console etc. is slightly in excess of the design figure of 0·3 secs. A corrected curve (3(*b*)) which includes the expected absorption of the carpet, is included in this figure; it shows close agreement with the original design calculations which included the effect of the carpet.

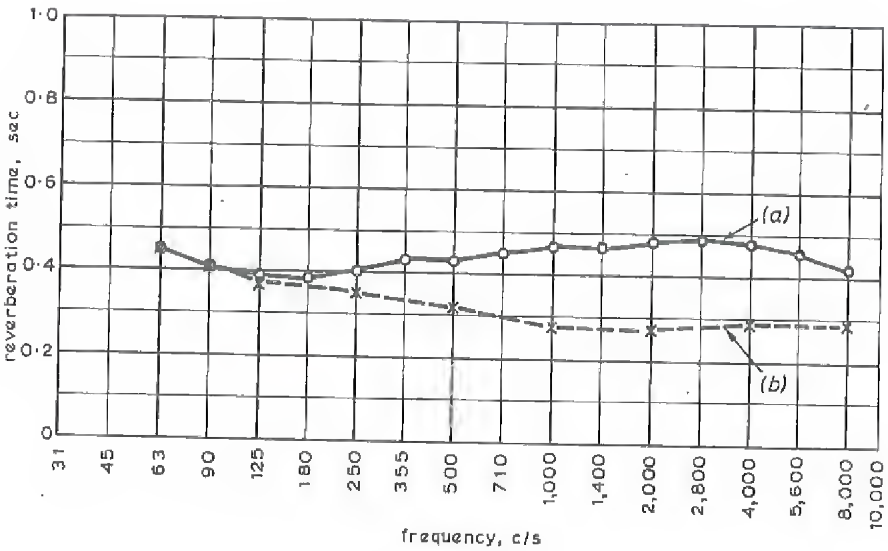

Fig. 3 - Reverberation time of cubicle

(*a*) Measured (*b*) Estimated with carpet

4.4. Ventilation Noise

No measurements were possible since the system was not operational.

5. CONCLUSIONS

1. The modifications to the floor have proved successful in eliminating the long decay resonances which made the studio unsatisfactory for music.

2. The acoustics of the studio and cubicle are likely to be satisfactory, except that it will probably be necessary to increase the absorption in the studio above 1 kc/s.

3. Sound insulation from the exterior is expected to be moderately good, although aircraft will certainly be heard during transmissions. Detail work to reduce leakage around the edges of the shutters may give some improvement.

CHD

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